MERCURY POISONING IN THE AMAZON: THE TIP OF THE ICEBERG

Speaker : ***Dr. Jean Lebel***, Senior Program Officer,
Ecosystem Approaches to Human Health Program Initiative,
International Development Research Centre (IDRC)
E-mail : jlebel@idrc.ca

People living in the Amazon suffer from mercury poisoning as a result of eating contaminated fish. For years, mercury used in gold mining was thought to be the sole cause. Then a team of Brazilian and Canadian Researchers, funded by the International Development Research Centre (IDRC), took a fresh look at the problem. To their surprise, they found another, unanticipated source of mercury in the environment. Today, this ongoing investigation continues to shed new light on the relationship between human health and the ecosystem.

The problem

Over the past decade, an increasing number of studies have reported that fish in some rivers of the Amazon region are contaminated with mercury. Likewise, people who live along those rivers and depend on fish for a major part of their diet have relatively high levels of mercury in their hair (an indication of mercury

exposure). Until recently, it was believed that the widespread mercury contamination resulted from the use of mercury to extract gold from the river's sediment and soil - a method used to this day.

Concerned about the effects of mercury on human health in the Amazon, scientists from the Federal University of Pará in Belém and the Université du Québec à Montréal (UQAM) teamed up in 1994 to explore the problem further. Their focus was Brazil's Tapajós River, where thousands of miners or garimpeiros have panned for gold in the last 30 years.

With support from the International Development Research Centre (IDRC), the team's initial research revealed the first surprise. Levels of mercury contamination were constant all along the Tapajós River, even hundreds of kilometres downstream from gold mining operations where one would expect mercury levels to be lower. Why? To find the answer to this puzzling question, IDRC provided additional funding to the team for what has become an intriguing, multi-disciplinary study.

Why are scientists concerned about mercury?

The presence of mercury in the food chain and its absorption by humans is universally recognized as a potential health hazard. Once mercury is released into rivers, lakes, and other aquatic environments, bacteria can transform the mercury into its organic form - highly toxic methylmercury. In this form it can be absorbed by the aquatic fauna, increasing in concentration (biomagnifying) as it moves up the food chain to fish and then to humans.

One of the best-known cases of methylmercury poisoning was discovered in 1956 in communities near Minamata Bay, Japan, where mercury discharged from a chemical plant accumulated in fish. Thousands of people who lived in the area and ate fish and shellfish from the bay developed symptoms of what came to be known as Minamata Disease. Symptoms of this disorder, which attacks the nervous system and brain, may include numbness of limbs and the area around the mouth, muscle weakness, an unsteady gait, tunnel vision, slurred speech, hearing loss, and abnormal behavior such as sudden fits of laughter. More aggravated symptoms include general paralysis, difficulty in swallowing, convulsions, and death. Methylmercury also cripples neural development in fetuses and passes much more readily into the brains of young children than adults.

Discovering another source of mercury

When the project began in 1994, the team's main focus was to find the source of mercury in the Tapajós River region, to understand how people in the area were being contaminated with mercury, and to examine its impact on their health.

The researchers set out for Brazil, intent on living like the people who dwell along the Tapajós River - eating fish twice a day. Within one three-week period, the concentration of methylmercury in their own hair doubled or tripled. They also began to sample levels of mercury in the water, sediment and soil at intervals along the river, starting at gold mining sites and ending hundreds of kilometres away. They expected mercury levels to drop as distance increased from gold mining operations, but instead the concentrations were relatively constant. Moreover, there was essentially no difference in mercury exposure levels between villagers living 100 kilometres downstream and those residing 300 kilometres away from the gold-mining area. This raised suspicions that there must be another source of mercury, apart from gold mining.
Mercury in the environment and water is always associated with the fine particulate matter because of the ability of metal to adsorb on them, and in a river these particles settle in the riverbed. So the team collected sediment cores all along the river and laboriously measured the levels of mercury every half centimetre. The most recent layers of sediment contained 1.5 to
3 times more mercury than layers of sediment deposited 40 years ago, even 400 kilometres downstream from the mines. Another examination of soils along the river bank revealed a higher concentration of mercury in surface soils. The team's conclusion: mercury had been released from the soil by the cutting and burning of trees along the river banks, which began 40 years ago when poor immigrants from northern Brazil began to colonize the Tapajós River basin.

"Slash and burn" agricultural practices in the region are responsible for the well publicized deforestation of 25,000 to 50,000 square kilometers of the Amazon per year (20% of the original surface has been deforested so far.) Since waterways are the major means of access to the region, deforestation is particularly apparent along their banks. Once the land is deforested, rain washes soil at the top of banks into the
river. Mercury, which had naturally accumulated in these soils for up to 100,000 years, was washed into the river too. Along the Tapajós River, in some areas, up to 15 centimetres of surface soil have been lost. It is this process that may largely explain the increase in mercury in newly colonized watersheds of the Amazon.

In 1996, the team also discovered a link between the seasons and the amount of methylmercury in people living in one of the villages along the Tapajós River. It turned out that contamination was highest during the rainy season, when large carnivorous fish grew in number. This new correlation was of great interest to those who rely heavily on fish as part of their diet.

Shedding new light on the health effects of methylmercury

Although none of the people who lived along the Tapajós River displayed the severe clinical signs of Minamata disease, the team wanted to know whether the level of mercury contamination they experienced was having an impact on their health.

In the village of Brasília Legal, situated about 250 kilometres downstream from the most extensive gold-mining area of Brazil, they discovered that hair samples taken from adults contained an average mercury level of 15.9 micrograms per gram (15.9 parts per million). This amount of exposure is well below the threshold of 50 micrograms per gram considered "safe" by the World Health Organization (WHO). The WHO threshold is based on the lowest level at which scientists in previous studies have reported the first clinical signs of mercury poisoning in adults.

However, when the team conducted simple coordination and vision tests on the same people from Brasília Legal, it was clear that they had experienced a decline in their coordination, manual dexterity and certain visual functions — such as the ability to distinguish contrasting lines. In fact, the study revealed a direct relationship between declining coordination and increasing levels of methylmercury in people's hair. Eureka! Contrary to conventional wisdom, the team had discovered that mercury can damage human health even at levels well below accepted international safety standards.

Pioneering study

This study is one of the first to illustrate the harmful effects of low-level exposure, and is thus contributing to international discussions on the need to lower the WHO threshold for mercury exposure. In the meantime, no one knows whether the residents of Brasília Legal or other villages along the Tapajós will eventually develop any of the advanced neurological symptoms associated with methylmercury poisoning - including loss of peripheral vision and speech problems. The research serves as an early warning sign that more serious neurological problems could develop, but it is hoped that efforts to reduce mercury consumption in the region will reduce this likelihood. The same group of people from Brasília Legal will be tested again in the year 2000 to measure changes in mercury levels and to determine the impact of intervention projects on human exposure to mercury. The researchers may then have a better idea of whether impaired motor and visual function can improve if exposure to mercury is reduced.

Turning research into action

The Amazonian ecosystem is very complex - the foodchain, for example, is longer and more complex than any found in more northerly climes. For this reason, more research is needed to develop a complete picture of how mercury behaves in this environment. In the meantime, the team is working with community members to develop short, medium, and long-term solutions.

In the short term, the focus is on diet. Fortunately for the local people, who derive much of their protein from fish, reducing exposure to mercury does not mean giving up fish. There are more than 40 fish species in the river, each with varying amounts of mercury contamination.

So far, the team has collected and examined some 500 fish samples, taken from the same sites that local fishermen frequent. In the process they highlighted that herbivorous or plant-eating fish contain very little mercury, while predatory fish contain the most and omnivorous fish fall in between. Likewise, people who predominantly eat herbivorous fish were found to have less mercury than those who eat more predatory fish. Surprisingly, the juveniles of some species contained more mercury than the adults. The researchers also discovered seasonal variations in hair mercury levels, reflecting the different availability of fish species during the rainy and dry seasons.

Based on this new knowledge, the team has been working with community members to propose fish diets which contain a greater proportion of fish with low mercury levels. Women in the village suggested they could use a poster illustrating each species and where it falls in the range of mercury contamination.

In the medium term, scientists are also working with fishers to identify "hotspots" - areas in the river with conditions that highly favour the transformation of mercury into toxic methylmercury (methylation). A third, longer term area for intervention is to reduce the overall level of mercury in the environment. One solution being explored is reforestation and agriculture. In collaboration with local farmers, the team plans to test which type of trees are best able to reduce the leaching of natural mercury into the river. If they can find fruit trees that do the job, all the better, since they would provide another source of food.

A new network for mercury research

Building on this research, IDRC recently provided new funding for the establishment of an interdisciplinary network of researchers and a reference centre related to mercury contamination in the Amazon. The main goal is to gather existing scientific knowledge about the behaviour of mercury in the Amazon, its transmission in the food chain, and its neurotoxic and health

impacts. This knowledge will then be used to develop concrete solutions to decrease mercury intake by local populations, to improve their general health conditions, and to reduce the level of methylmercury in the ecosystem. The reference center will be the first bank of standardized data on mercury in the Amazon - its sources and its impact on the food chain and human health. Eventually, this information will be made available to anyone through a web site.
Human health and the environment: IDRC's multi-disciplinary approach

The investigation into the cause of mercury contamination in the Amazon is one of many projects being funded under the umbrella of IDRC's program initiative on "Ecosystem Approaches to Human Health." The goal of this initiative is to improve human health by supporting trans-disciplinary research on the structure and function of stressed ecosystems on which people depend for their lives and livelihoods. This knowledge can then be used to develop interventions and policies toward the better management of ecosystems in order to improve human health and well-being while simultaneously maintaining or improving the health of ecosystems as a whole.

Trans-disciplinary research offers a more holistic approach to understanding environmental problems and risks, and finding sustainable, cost-effective solutions. Today, the team that is exploring mercury contamination in the Amazon includes a neurotoxicologist, and specialists in ethnobotany, cytogenetics,sociology, biogeochemistry, the environment, and forestry from the Amazonian Federal University of Para (UFPa) in Belém, the UFPa outreach campus in Santarém, the Federal University of Rio de Janeiro, the University of Quebec at Montréal (UQAM), the Montréal Biodome, and the Grupo do Defencia do Amazona in Santarém. Another important element of this project is community involvement, in both the research and the development of solutions.